Curriculum S. 20

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ONTARIO

Department of Education

Courses of Study

Grade 13

PHYSICS

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PHYSICS, GRADE 13

Introduction

The purposes in view are as follows:

1. To present a course with sufficient balance between experiment and theory to hold the interest of the average pupil.
2. To make a survey of the general field of physics illustrated by experiments and discussions of modern physics and its applications.
3. To present some branch of physics (e.g. mechanics) in sufficient detail to show the logical development of the subject from fundamental principles.

Calculations

The students should be taught to appreciate the fact that all numbers obtained by measurement are approximate and that in any calculation involving measured quantities, the accuracy of the result will depend on the accuracy of the least exact factor in the calculation.

(a) Mechanics

Motion. (Seventeen periods.)

Force, inertia and Newton's First Law of Motion.

Velocity and acceleration. Concept of motion, of uniform, variable, and average velocity and of uniform, variable, and average acceleration. Graphical representation of uniform motion and of uniformly accelerated motion. Velocity at a point. Definition of a vector quantity. Recognition of force, velocity and acceleration as vector quantities. (Note: Since the resolution and composition of vector quantities is an integral part of the Grade 13 course in Trigonometry and Statics, that topic is not included in this course.)

Experimental determination of acceleration due to gravity. Illustrative experiments with the Galileo board or the Fletcher trolley. Problems.

(Seventeen periods.)

Newton's Second Law of Motion with experimental illustrations. Mass and Weight. Momentum and impulse. Gravitational and absolute systems of units: British Engineering (F.P.S.); Metric (C.G.S. and M.K.S.). Problems.

A discussion of the Law of Universal Gravitation with brief reference to illustrative experiments.

(Seven periods.)

Newton's Third Law of Motion.

Law of Conservation of Momentum. Applications and problems. Centripetal and centrifugal forces. Applications. (Numerical problems not required.)

Energy. (Eighteen periods.)

Work, energy and power, with applications and problems.

Definition of units: erg, joule, gram-centimetre, foot pound, watt, horsepower, kilowatt hour, watt-second.

Gravitational potential energy: definition; derivation of formula (mgh); brief reference to other forms of potential energy.

Kinetic energy: definition; derivation of formula ($\frac{1}{2}mv^2$). Problems related to kinetic energy and to gravitational potential energy.

Discussion of Joule's determination of mechanical equivalent of heat. Meaning of the efficiency of a machine.

Friction.
(Five periods.)

Experiments to illustrate static, limiting static, and kinetic friction.

Experimental determination of the coefficients of static and kinetic friction.

Laws of friction (numerical problems not required).

Discussion, with familiar illustrations, of the advantages and disadvantages of friction.

(b) Electricity

Electrostatics.
(Eight periods.)

A review and extension of electrostatics of Grade 11 or 12.

An experiment to show that both positive and negative charges are induced on an uncharged insulated conductor when a charged body is brought near it.

Demonstration and discussion of the charging of an insulated conductor by induction. Explanation in terms of electrons.

An experiment to show that a charge placed on an insulated hollow conductor goes to the outer surface.

A brief discussion of shielding with practical applications, e.g. in a radio tube.

An experiment to show the escape of a charge from a point. e.g. Franklin's experiment. The lightning rod.

Electrical energy.
(Eight periods.)

Review the meaning of work, energy, and power, with emphasis on gravitational potential energy. A demonstration with a positively charged pith ball (at the end of a short silk thread tied to a glass rod) between two charged insulated plates, one positive, the other negative, to show (1) the existence of a force acting on the pith ball anywhere in the region between the plates, (2) that the pith ball, if free to move, will go from the positive to the negative plate, and (3) that work must be done on the pith ball to move it from the negative to the positive plate.

Explanation of the meaning of electrical potential difference as a difference in electrical potential energy per unit charge.

Definition of the volt as a joule per coulomb, $E=QV$ where E is the electrical energy in joules, Q is the quantity of charge in coulombs and V is the potential difference in volts.

Motion of free charges whenever an electrical potential difference exists; meaning and measurement of electrical current.

Measurement of electrical energy and power in terms of potential difference, current, time, and resistance (e.g. $E=VIt$, $P=VI$). Electrical power in watts and kilowatts, electrical energy in kilowatt-hours. Calculation of the cost of energy to operate electrical appliances.

Electrical method of measuring the mechanical equivalent of heat. Simple problems.

Capacitance. (Seven periods.)

An experiment with an electroscope and attached insulated plate to show the variation of capacitance with (1) area of plate, (2) distance between the charged plate and a grounded plate, and (3) the nature of the dielectric. Structure and uses of capacitors of different forms. $Q=CV$ where Q is the quantity of electricity, C the capacitance, and V the potential difference. The farad, the microfarad and micro-microfarad. Simple problems. An experiment with an electroscope and a capacitor to show the presence and the nature of the charge on each terminal of a voltaic cell or battery.

Electron emission. (Seven periods.)

(a) thermionic

An experiment with a diode tube to show that a current passes through the tube if (1) the filament is hot, and (2) the filament is negative with respect to the opposite electrode.

Simple discussion of the liberation of electrons from a hot metal.

Experiment using A.C. to show the use of a diode tube in allowing current to flow in one direction only.

The meaning of rectifier and rectification.

The use of the triode tube as a simple one stage audio amplifier.

(b) photoelectric.

An experiment to show that when light from a carbon arc falls on a clean zinc plate connected to a negatively charged electroscope the electroscope loses its charge. The meaning of photoelectricity; the structure and uses of a simple photoelectric cell and of a photovoltaic cell.

Cathode ray tube. (Five periods.)

The principles of the cathode ray tube with the electrostatic deflection of the beam. Use of tube in the Cathode-ray oscilloscope with a saw-tooth signal to form a time base for the study of wave form, (no circuit diagrams required).

The basic principles of the Cathode ray tube used in the television camera (iconoscope or image orthicon) and in the television receiver, (circuit diagrams not required).

(c) Energy Transmitted By Waves

Sound. (Five periods.)

Discussion of the principle of superposition of waves by means of graphs representing two trains of waves having the same frequency and equal amplitudes and travelling with equal

velocities along the same line but in opposite directions. Experiment with a cord under tension to show standing waves. Nodes and loops. An experiment to show standing sound waves in an air column and to measure the wave-length and the velocity of sound in air. An experiment to determine the frequency of a tuning fork.

(Four periods.) A mechanical illustration and an explanation of resonance. Resonance illustrated by experiments (1) with tuning forks or resonance bars of the same frequency (sympathetic vibrations), (2) with tuning fork and an air column whose length can be altered.

(Four periods.) Experiments to illustrate the interference of sound waves due to superposition: (1) silent points near a sounding tuning fork; (2) Herschel's divided tube. Discussion of the use of interference in Herschel's divided tube to measure the wave-length of sound. The production of beats.

Light.
(Six periods.) An experiment with pins and a glass block to measure the index of refraction from air to glass. Proof that $\frac{\text{Sin i}}{\text{Sin r}} = \frac{v1}{v2}$ where v_1 = velocity in the first medium and v_2 the velocity in the second.

The following simple experiments to show that the transmission of light has the characteristics of a transverse wave disturbance:

(a) An experiment to show the diffraction of light when a single straight incandescent filament is viewed through a narrow aperture, e.g. a narrow crack between two fingers held before the eye.

(b) An experiment to show interference of light when the single filament is viewed through two narrow parallel slits.

(c) An experiment to show interference with light reflected from a thin soap-film.

(Two periods.) An experiment with sodium flame and air wedge between two glass strips to measure the wave-length of sodium yellow light.

(Seven periods.) An experiment to show deviation through a prism. Experiments to demonstrate the spectrum of white light and the combination of spectrum colours to form white light. A discussion of a range of wave-lengths in the visible spectrum. An examination, by looking through a diffraction grating or a spectroscope, of the flame spectrum of a few common elements such as sodium, calcium, and lithium and of the vacuum-tube spectra of such gases as neon, nitrogen and hydrogen (an inexpensive diffraction grating will serve).

A brief discussion of spectrum analysis and the uses of the spectroscope and the spectrograph. A brief discussion of the

infra-red and of the ultra-violet portions of the spectra and of applications of these radiations.

Polarization.
(Four periods.)

Experiment with two pieces of polaroid to show the nature of plane polarized light. Discussion of the use of polaroid in three dimensional pictures.

An experiment with a piece of polaroid to show polarization by reflection from non-metallic smooth surfaces. Discussion of the use of polaroid in overcoming glare due to reflected light.

Radiant energy.
(Five periods.)

Experiments to show (i) the difference in the absorption of radiant energy by a dark and by a polished surface, and (ii) the difference in the emission of radiant energy by such surfaces.

A discussion, with experiments where possible, of means of detecting radiant energy, such as (i) the blackened bulb of a thermometer, (ii) Crookes radiometer, (iii) a thermocouple, (iv) photoelectric or photovoltaic cell, and (v) photographic plate.

Discussion of (i) the reason for silvering a vacuum flask and polishing a calorimeter, and (ii) the reasons for the rise of temperature in a hot-house.

Law of inverse squares.
(Five periods.)

Geometrical derivation of the Law of Inverse Squares for any kind of radiation from a small source, when there is no absorption.

Experimental verification by the use of a photometer with two light sources of known candlepower, or by use of a photoelectric cell with a single source of unknown candlepower, or by a hot ball and thermocouple.

Experiment to compare the candle-power of luminous sources by any type of photometer.

Brief reference to the foot-candle meter and the exposure meter.

X-rays.
(Two periods.)

An experiment with a small cold cathode X-ray tube and an induction coil to show (1) the discharge of an electroscope by X-rays, and (2) the passage of X-rays through such substances as wood and paper.

Brief reference to the origin, uses, and wave-lengths of X-rays, and to their application.

Electromagnetic waves.

Brief reference (illustrated if possible by one or more experiments, such as Lodge's resonance experiment) to oscillatory electric circuits and the generation of electric waves.

A discussion of the range of wave-lengths of electro-magnetic waves, including radio waves. The meaning of kilocycles per second, and the relation of frequency in kilocycles per second to the wave-length in metres.